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60/486566
07/11/03

PROVISIONAL APPLICATION FOR PATENT COVER SHEET

This is a request for filing a PROVISIONAL APPLICATION FOR PATENT under 37 CFR 1.53 (c).

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TITLE OF THE INVENTION (500 characters max)

True CD

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08791

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ENCLOSED APPLICATION PARTS *(check all that apply)*

☒ Specification *Number of Pages* 8

☐ Drawing(s) *Number of Sheets*

☐ Application Data Sheet. See 37 CFR 1.76

☐ CD(s), Number

☐ Other (specify)

METHOD OF PAYMENT OF FILING FEES FOR THIS PROVISIONAL APPLICATION FOR PATENT *(check one)*

☐ Applicant claims small entity status. See 37 CFR 1.27.

☒ A check or money order is enclosed to cover the filing fees

☒ The Commissioner is hereby authorized to charge filing fees or credit any overpayment to Deposit Account Number: 02-2666

☐ Payment by credit card. Form PTO-2038 is attached.

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The invention was made by an agency of the United States Government or under a contract with an agency of the United States Government.

☒ No

☐ Yes, the name of the U.S. Government agency and the Government contract number are:

Respectfully submitted,

SIGNATURE _____ Date 7/11/2003

TYPED or PRINTED NAME Tarek N. Fahmi REGISTRATION NO. *(if appropriate)* 41,402

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USE ONLY FOR FILING A PROVISIONAL APPLICATION FOR PATENT

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UNITED STATES PROVISIONAL PATENT APPLICATION

For

TRUE CD

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True CD

Problem definition

[0001] Classical CD metrology using Top-Down SEM scanning (top view) measurements gives satisfactory accuracy and matching relative to other techniques (AFM, Cross Sections, OCD) in general. However, when the specimen edge width (from top-down scanning) is the same order of magnitude or smaller then the Beam-Print (see figure 1), this measurement become less reliable and less sensitive to changes (see figures 2 and 3).

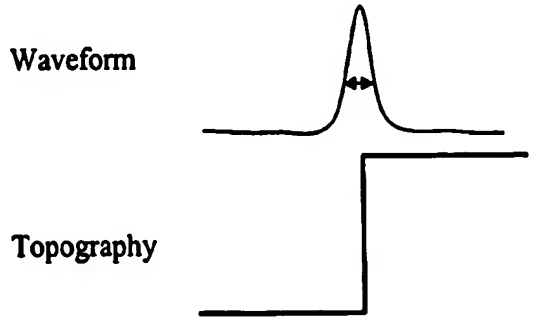

Figure 1: Beam-Print - The edge width (EW) as measured on the waveform generated by scanning a 90 deg slope

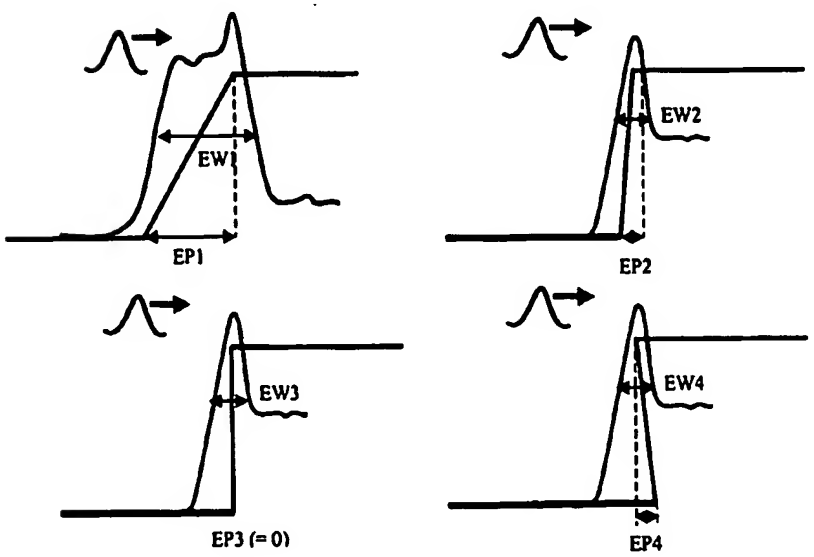

Figure 2: The Edge-Width (EW) is insensitive to changes of actual edge projection (EP)

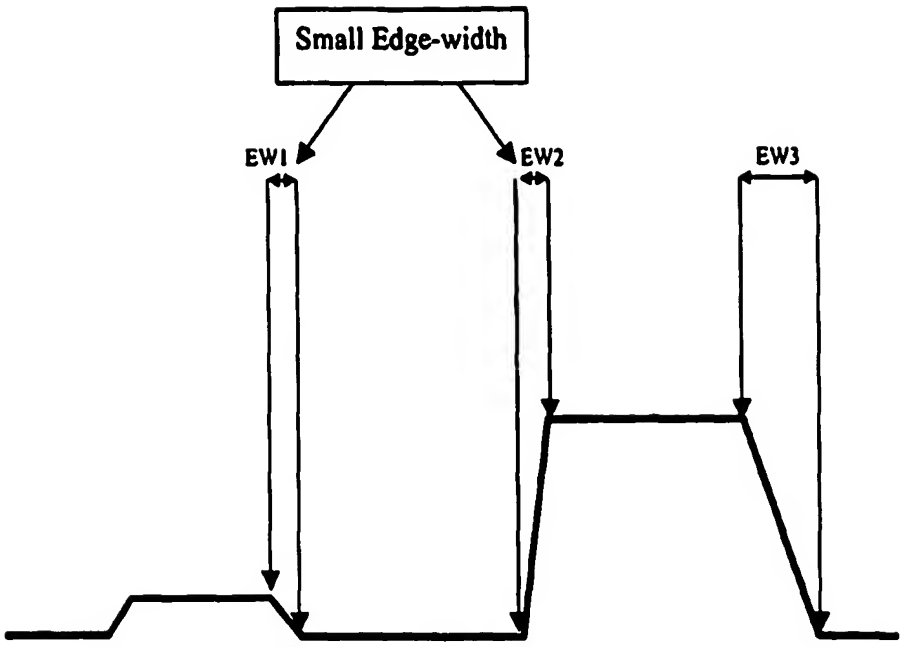

Figure 3: Small edge width may exist due to steep slope (EW2) or small height (EW2).

[0002] This phenomenon is caused by the self-occlusion of the specimen bottom when viewing from the top view or by the fact that the SEM signal reflects the electron beam print rather then the actual edge-width. The bottom detection deteriorates when the sidewall become steeper. Until, there is no signal from the bottom of the edge in negative sidewall slopes.

[0003] Few methods were suggested to overcome this problem mainly by using only the tilted views of the CD measurement. These methods suffer from the symmetry assumption that can lead to a measurement error from one side. When symmetry is not assumed it requires many scanning/exposures of the features that can effect the feature size measurement and require longer measurement time (shrinkage, charging, etc.).

[0004] We suggest to use the information from the tilted views for CD measurement combined with marking a reference Point/Line over the wafer in order to overcome this problem.

[0005] In the framework of this approach, the Bottom CD values are calculated as result of the CD Marking points and the visible bottom point taken from two tilted views. This method allows improving the CD measurement accuracy for steep edges without assuming symmetry or the need of more than two scans of the feature.

[0006] The advantage of the proposed method that it is independent of the feature height and does not requires more than two scanning of the feature.

Strategy

[0007] **Option 1.** When true CD is required, we suggest to use the true CD measurement scheme as described in Figure 4.

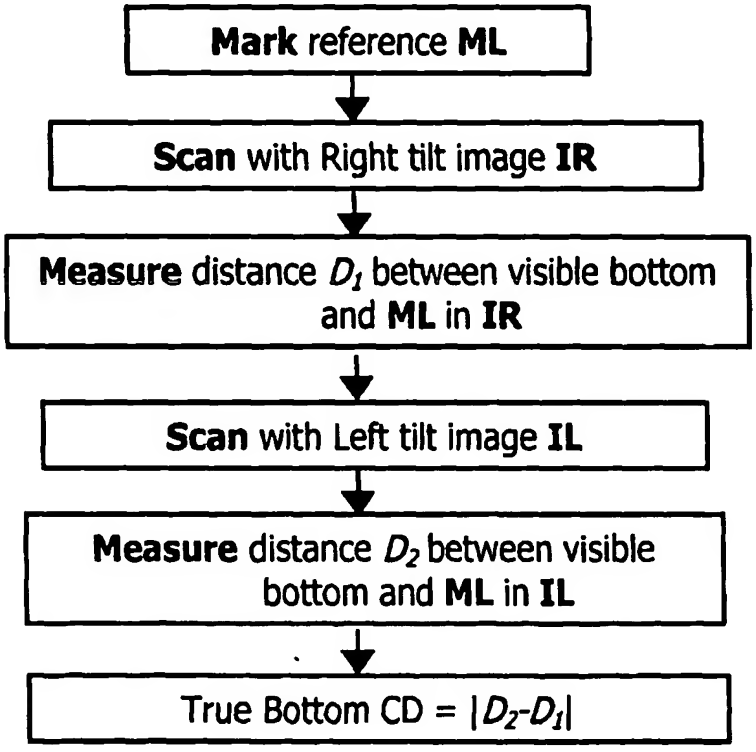

Figure 4: True CD Measurement Scheme details

The True CD scheme

[0008] This scheme combines the two tilt views, and the marking step; one view from each side. Here we do not assume that the height is given, since the measurement point lay on the level. The bottom CD can be easily calculated from the two tilts measurements. In addition we do not assume that the line is symmetric since we measurement is done from the two sidewalls.

[0009] The reference Marking (ML) can be done using the SEM scanning or alternatively trough a FIB device. The shape of the marking element can be point, Line, array of lines or any other feature/features that can be viewed and measured by the SEM.

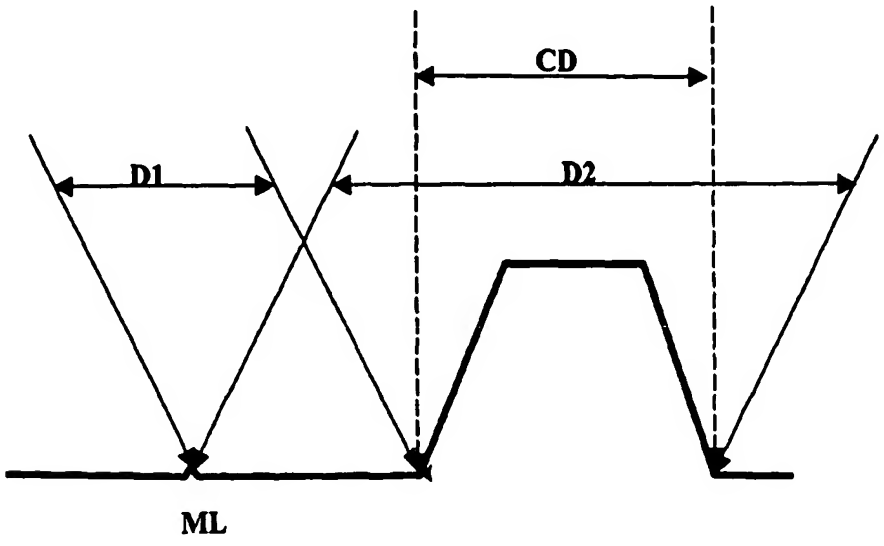

Figure 5: CD = D2-D1

Glossary

[0010] **IR** is the scanned image from the Right tilt see example in figure 6

[0011] **IL** is the scanned image from the Left tilt see example in figure 7

[0012] **ML** is the marked reference point, Line, Array of lines.

[0013] **CD** is the bottom measurement of the given feature

[0014] **D1** is the measured distance between the visible bottom and **ML** in **IL**

[0015] **D2** is the measured distance between the visible bottom and **ML** in **IR**

Example of IL: Left tilt scan image IL simulation

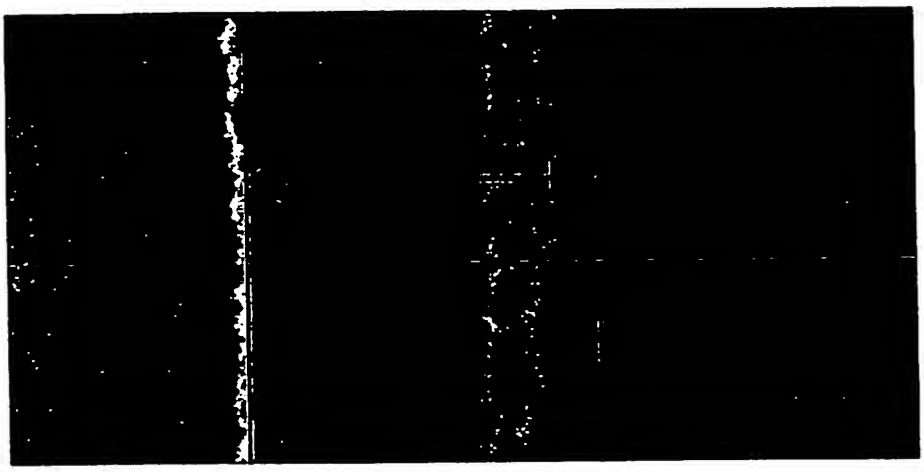

Figure 6

Example of IR: Right tilt scan image IR simulation

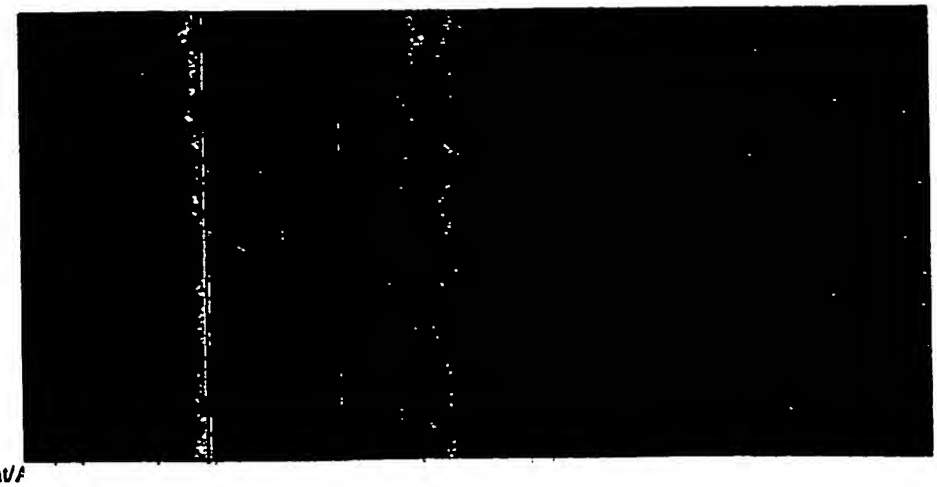

Figure 7

Option 2. Conditional target concept as follows:

[0016] We can use the preliminary scanning measurements to determine whether True CD scheme (Option 1) is required. Top-Down measurements are performed for low-slope edges and Tilted measurements are performed for steep edges. Note that the preliminary scanning may be performed in scan conditions different then the actual conditions of the final measurement (exposure, pixel size, etc.) or in the vicinity of the actual measured region (e.g. further up the measured line).

[0017] This condition can be determined by several methods. We describe these methods on the Conditions A, B, C, D and no condition at all.

Condition A - DIN

[0018] In this method we store a set of reference images that represent the state of the steep sidewall lines. Then using a distance function we decide whether the condition fulfill if the value is above some threshold. In the case that this condition fulfill we continue to Option 1. This distance function can be implement using the conventional Discrete Inspection methods such as correlation function , absolute distance ,...

Condition B – CD limit

[0019] In this method we determine a limit both upper & lower on the bottom CD measurement value. Whenever the measurement exceeds this limit then the condition is fulfilled and we continue to Option 1.

Condition C – Edge-width

[0020] In this method we determine a lower limit on the edge-width measurement value. Whenever the measured edge width is smaller than this limit, the condition is fulfilled and we continue to Option 1.

C ndition D – Function Fit

[0021] In this method we fit a family of functions to the waveform signal and we determine a limit both upper & lower on the fitted function parameters value. When ever the parameters exceed limit then the condition fulfill and we continue to Option 1. This family of functions can be any common mathematical function such as polynomials, exponentials, etc.

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